

Rapid Ecological Assessment of Forests and Associated Exotic Earthworms in the Laurentian Mixed Forest-Great Lakes Coastal Biological Network, Midwest Region, National Wildlife Refuge System, US Fish & Wildlife Service¹

FOREST COMMUNITY ANALYSIS: Horicon NWR

Differences in Overstory Composition Among Stands. Using relative basal area (%) by species of the 50 plots sampled across 10 stands at Horicon NWR as part of the Rapid Ecological Assessment (Corace et al. 2011), we used a Multi-Response Permutation Procedure (MRPP) to examine if there are differences in the *overall overstory composition* among the 10 stands. MRPP is a non-parametric technique that tests the hypothesis that there is no difference between groups of entities, in this case the overstory composition of stands at Horicon NWR.

We conducted a MRPP using Sorenson's distance and PC-ORD (ver. 5.0) software. As there were five plots that contained no overstory, we added a dummy variable to the dataset prior to analysis indicating no overstory component for these plots. Additionally, prior to analysis, we deleted five species that occurred on < 5% of the total plots, including boxelder, black maple, red maple, sugar maple, and American elm. These 'rare' species (in terms of occurrence as part of this sample) can exert an undue influence on these multivariate statistics.

Overall, there is a statistically significant difference in the overstory composition among the stands ($T = -12.097$; $A = 0.307$; $P < 0.001$). The results of the MRPP support the data as described in the SUMMARY TABLES & FIGURES document for the Horicon NWR that suggest differences in the overstory composition (Corace et al 2011). We also calculated post-hoc pairwise comparisons between stands and found statistically significant ($P < 0.05$) differences except for the following stands: BRDG and OSRN; BRDG and OSRS; OSRN and OSRS; PNT and ROCK; RDX and STER. In these instances, the overall overstory species composition as expressed by relative basal area is similar.

Indicator Analyses. In order to predict if there are significant overstory indicator species for each stand at Horicon NWR, we used Indicator Species Analysis following the procedure outlined in Dufrene and Legendre (1997). We used PC-ORD (ver. 5.0) to conduct the Indicator Species Analysis using the relative basal area (%) of those species occurring on at least 5% of the total plots sampled, and included a dummy variable (NONE) to indicate plots where no overstory was found.

Based upon the Indicator Species Analysis, we found the following species were significant indicators ($P < 0.05$) of the following stands:

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Stand	Indicator Species
BRDG	bur oak
EGRT	black cherry
HDQT	black ash
HUNT	black oak
OSRN	no indicator species
OSRS	no indicator species
PNT	no indicator species
RDFX	bigtooth aspen
ROCK	American basswood
STER	northern red oak

Gradient Analysis. Using relative basal area by species (%) of the 50 plots sampled across the different stands at Horicon NWR as part of the Rapid Ecological Assessment (Corace et al. 2011), we examined the distribution of overstory species across sampled stands using Non-Metric Dimensional Scaling (NMDS). NMDS is a non-parametric ordination analysis that maximizes the rank-order correlation between distances. Unlike other indirect (e.g., principal components analysis) or direct (e.g., canonical correspondence analysis) ordination techniques, NMDS does not make any assumptions about the nature of the data, including assumptions about the linear relationship among variables. As a result, it is often viewed as an appropriate multivariate analysis for ecological data (McCune and Grace 2002).

Prior to the analysis, the relative basal area data by species were transformed using an arcsin squareroot transformation as is appropriate with percentage data. We also deleted those species occurring on < 5% of the total plots ($n=5$) and added a dummy variable (NoNe) for those plots sampled without any overstory. NMDS was then run using PC-ORD (ver. 5.0) software using a Sorenson distance measure. A three-dimensional solution was determined to be the most appropriate (Monte Carlo test, $n = 200$ runs).

Despite the MRPP suggesting there are differences in the overstory composition of forested stands at Horicon NWR, there appears to be considerable plot-to-plot variability in overstory relative basal area as indicated by the overlap of plots representing the different stands in the NMDS ordination (Figure 1). Overall the results of the NMDS appear to support that there are distinct forest overstory communities at Horicon NWR. For example, it appears that there are three major types of forest communities based upon this analysis:

- 1) a wet-mesic forest community dominated by black ash, bigtooth aspen, and American basswood (stands ROCK, HDQT, and RDFX);
- 2) a dry mesic forest community dominated by northern red oak and black oak that may have been disturbed as evidenced by the open areas sampled where no overstory was found (stands STER, OSRS, and HUNT); and
- 3) a xeric forest community dominated by bur oak (stands EGRT and BRDG).

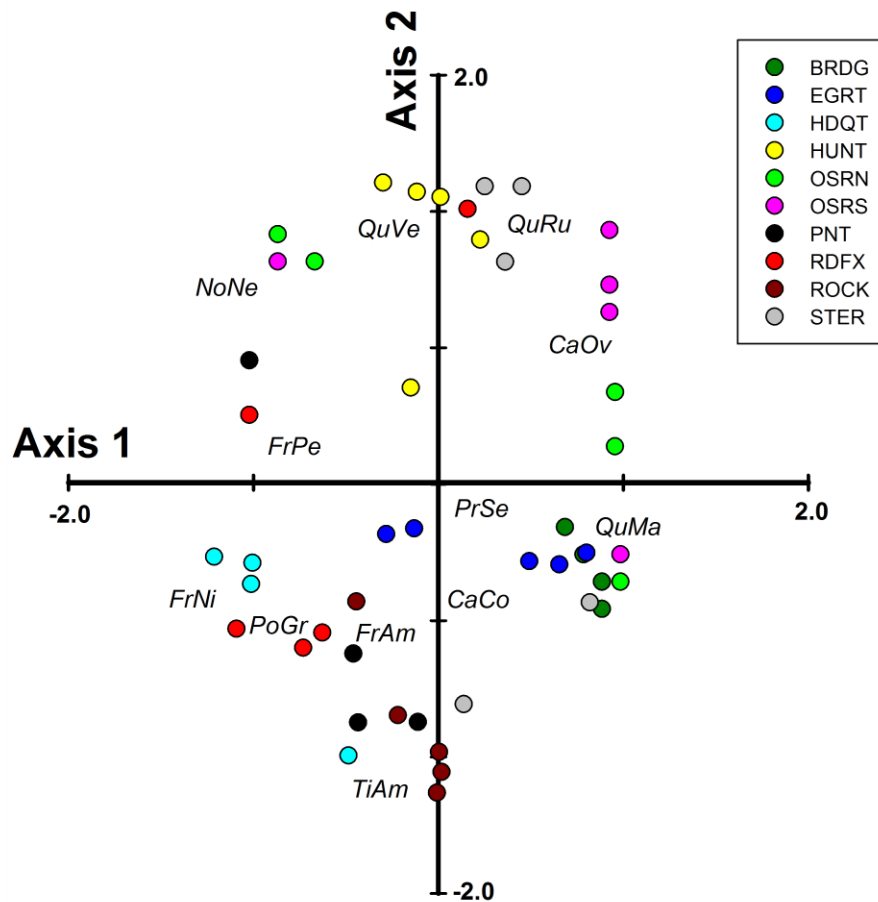


Fig. 1. NMDS ordination of overstory species based upon relative basal area for 10 stands at Horicon National Wildlife Refuge. Species acronyms correspond to first two letter of genus and species (e.g., QuRu = *Quercus rubra*). Only those species with a cutoff value of 0.20 included in ordination diagram.

However, despite these general patterns the NMDS also suggests there is considerable variability within stands in terms of overstory relative basal area as indicated by the individual sample plots that are distributed across the ordination diagram (e.g., while the OSRS stand is best characterized as a dry-mesic forest based upon overstory composition, there is one plot that is more closely associated with the xeric forest community type dominated by bur oak; Fig. 1). These differences indicate there are environmental gradients within individual stands at Horicon NWR that result in different overstory communities. More information (e.g., soils, past history) on these different stands and plots is needed to make a more conclusive statement regarding the factors driving patterns in overstory composition.

Analysis Implications. These basic results confirm the summary information developed by Corace et al. (2011). Specifically, there are unique forest communities at Horicon NWR that are dominated by a mixture of species that most likely reflect dominant environmental and disturbance gradients of the region. While there appear to be three major forest community types, the analyses also strongly indicate that there is considerable variability at local scales within each stand. These results suggest that

individual stands may include different overstory communities in response to varying environmental or disturbance related factors within each stand. While overall it may appear that an effective management strategy may be to treat individual stands as separate management units, the within-stand variability may require different management recommendations and guidelines depending on management objectives. Management activities, including forest ecosystem restoration practices, would need to be tailored for each specific condition.

References:

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